NUI Galway
OÉ Gaillimh

Semester 2 Examinations 2014

Exam Code(s)	4BCT
Exam(s)	B.Sc. in Comp Sc. & Information Technology
Module Code(s)	CT420
Module(s)	Real-Time Systems
Paper No.	1
Repeat Paper	N
External Examiner(s)	Dr. John Power
Internal Examiner(s)	Prof. Gerard Lyons Dr. Michael Madden *Dr. Hugh Melvin

Instructions: Answer any 3 questions. All questions carry equal marks.

Duration	2 hours
No. of Pages	5
Discipline	Information Technology

Requirements:

MCQ
Handout
Statistical/ Log Tables
Cambridge Tables
Graph Paper
Log Graph Paper
Other Materials

Release to Library: Yes [X] [ ]

Section A

Q1

(i) An Anti-Lock Braking System (ABS) is designed to maximise the braking effectiveness by periodically checking for wheel locking (i.e. skidding), and momentarily releasing the brakes if required so that the wheel stays connected to the road as much as possible, rather than sliding on a thin layer of water/rubber.

Using this example, distinguish between, and give estimates for, both the Sample Rate and Response Time of the ABS system, and show how these terms are related. You can assume that max speed of a car is 150 kilometres per hr which in a worst case scenario means a relative closing speed between 2 cars of 300 kilometres per hr .

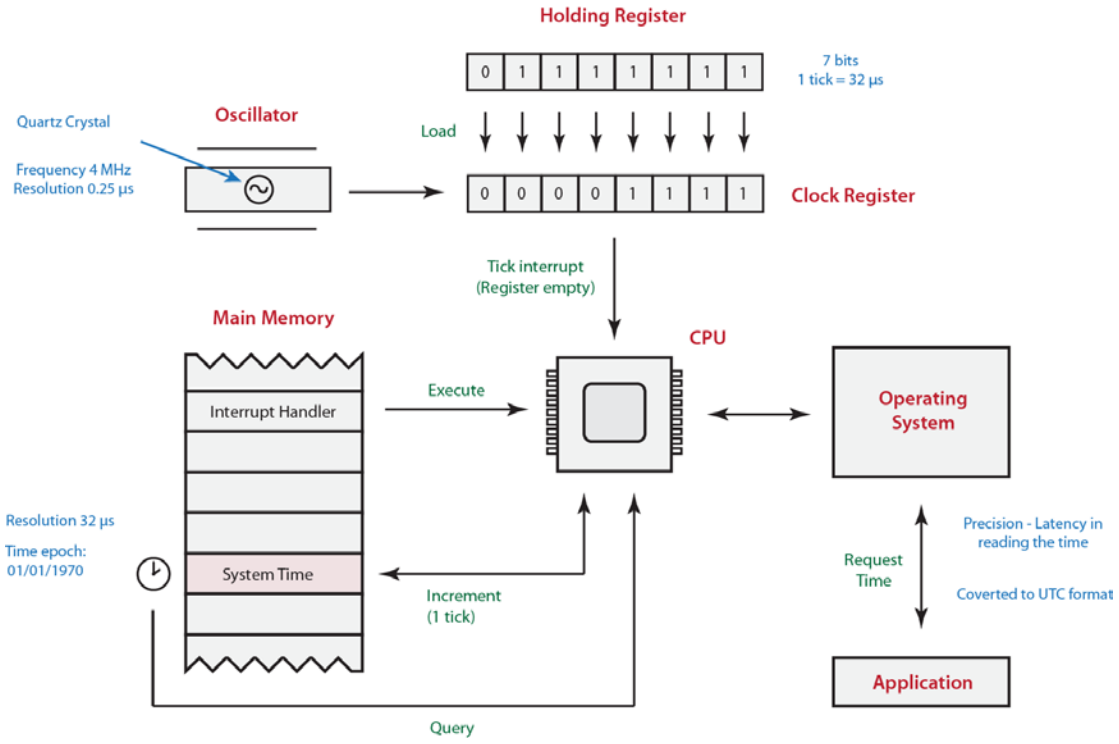
[10]

(ii) The diagram below outlines a high level view of a typical computer system clock. Describe in some detail how it operates.

[15]

Comment on how clock granularity can impact on Fault Diagnosis in a distributed system using timestamped log files and describe how the 'Holding Register' shown below can be used to improve granularity.

[10]



(iii) The Unix system call clock_gettime() uses a timespec structure, shown here, to return system time in seconds and nanoseconds. Explain how the underlying Hardware/Operating System can impact on the returned values.

(5)

```
struct timespec {
time_t   tv_sec;        /* seconds */
long     tv_nsec;       /* nanoseconds */
};
```

Q2

(i) *An Electrical Power Line Fault Detection System requires precision **time** for correct operation whereas Cellular networks require precision **timing**.*

Outline whether you agree/disagree with this statement and explain your reason(s).

[5]

(ii) Your company wishes to install its own NTP time server to service a range of its local LAN applications/Servers requiring synch levels better than 5 msec. You are asked to decide on the choice of remote NTP servers with which to configure your server.

- Outline what are the key criteria to consider when selecting remote NTP servers
- Show how you would implement a test phase whereby you could assess the performance of various remote servers and the networks that connect them.

[20]

Explain what is meant by the key NTP metrics (delay, offset, reachability, jitter), and how you would use them to assess the performance of the servers and networks. What relationships if any would you expect to see between the following-

- Delay and Reachability
- Delay and Offset
- Delay and Jitter

[15]

Q3

(i) Describe in some detail how Voice over IP (VoIP) operates. Your answer should consider the following :

- Voice codecs
- Role and importance of Transport layer protocols RTP & UDP
- Role of the jitter buffer and jitter buffer algorithms
- Impact of codec choice, packet loss, and M2E (Mouth to Ear) delay on Mean Opinion Score

[20]

Show also how RTCP can be used to implement lip synch for Voice & Video over IP

[8]

(ii) In the context of RealTime Multimedia applications, distinguish briefly between QoS (Quality of Service) and QoE (Quality of Experience)

[4]

(iii) WebRTC and DASH are two important recent developments in Internet Multimedia services. Briefly describe what they are and how they work.

[8]

Q4

(i) Cyclic Executive approaches are typically deployed in Hard RTS environments. What are the advantages and disadvantages of this approach over one that uses multiple processes and a RealTime OS .

[15]

(ii) You have been asked to design the control software for an embedded system controller in a chemical process. The software is controlled by a cyclic executive. It controls 4 tasks with cycle times of 25 msec, 50 msec, and 75 msec as shown in Table 1 below. The execution time of each task is well below its cycle time.

Task	Period (msec)	Exec Time (msec)
A	25	10
B	50	5
C	50	5
D	75	2

Table 1

(a) Using C code, develop a timer-interrupt-controlled cyclic executive for the above task schedule. Your answer must include an implementation of the timer-interrupt service routine.

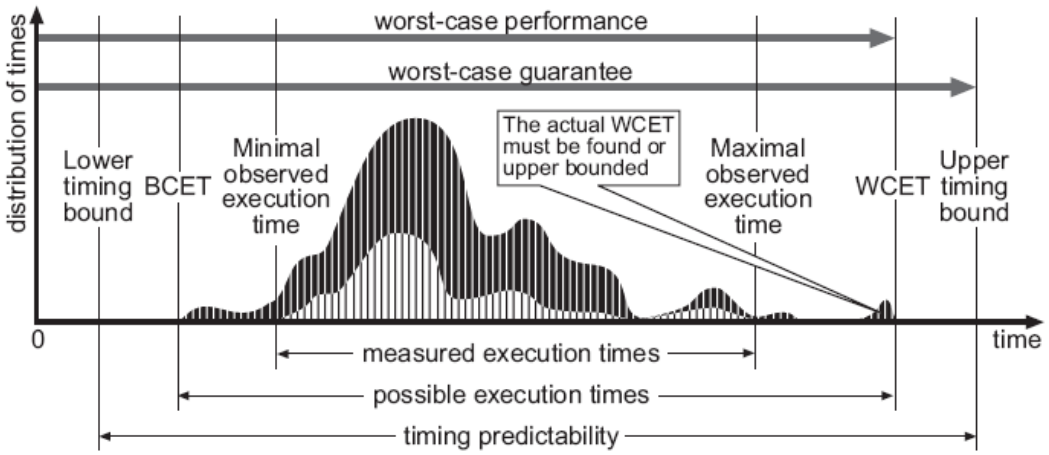
[15]

(b) The process hardware creates asynchronous interrupts that are handled by the control software via other interrupt service routines.
What is the potential issue here in regards to meeting the above cycle time constraints? Show how you can modify your cyclic executive from part (a) of this question to detect such violations.

[10]

Q5

(i) The diagram below illustrates the Worst Case Execution Time (WCET) for a sample task under both offline code analysis (dark shaded) and actual runtime testing (light shaded). Explain each of the indicated points and ranges in the diagram and outline the importance of such analysis in RTS design.



[10]

(ii) Using the task set in Table 2 below:

- Calculate the overall *CPU utilisation U*. [3]
- Determine and explain the process schedule using the *RM scheduling algorithm*. [8]
- Determine and explain the process schedule using the *EDF scheduling algorithm*. [8]
- Compare and contrast both scheduling algorithms. [6]

Task	Execution Time	Period
1	10	50
2	20	100
3	20	150
4	80	200

Table 2

(iii) How does static software redundancy using *N-version programming* work? [5]